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Indian Standard

GENERAL REQUIREMENTS FOR DIRECT READING POINTER INDICATOR TYPE ELECTRONIC VOLTMETER

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 *April* 1973

Indian Standard

GENERAL REQUIREMENTS FOR DIRECT READING POINTER INDICATOR TYPE ELECTRONIC VOLTMETER

(First Revision)

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*Shri Y. Venkataramiah was Chairman for the meeting in which this standard was finalized.

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Indian Standard

GENERAL REQUIREMENTS FOR DIRECT READING POINTER INDICATOR TYPE ELECTRONIC VOLTMETER

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 7 December 1972, after the draft finalized by the Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The revision of this standard has been undertaken to expand terminology, to modify other clauses in the light of standards being prepared on electronic voltmeters. Also this standard has been aligned as far as constructional requirements are concerned, with IS : 1248-1960* to the extent possible.

0.3 The object of this standard is to group together requirements common to all types of electronic voltmeters of direct reading pointer indicator type and the characteristics for which specific values should be assigned in the relevant individual specification. In addition this draft standard will be useful to ensure a uniform presentation of the characteristic to be declared by the manufacturer.

0.4 The provisions of this standard apply to complete apparatus and not to the component parts thereof.

0.5 The details of environmental requirements to be included are under consideration. With regard to the safety requirements, the electronic voltmeter covered by this standard should satisfy the requirements of IS : 616-1957† in so far as it is applicable.

0.6 In preparation of this standard, assistance has been derived from the following:

IEC Pub 217 (1967) Electronic voltmeters. International Electrotechnical Commission.

BS 4205 : 1967 Specification for electronic voltmeters. British Standards Institution.

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*Specification for direct acting electrical indicating instruments (*first revision*).

†Code of safety requirements for mains-operated radio receivers.

0.7 This standard is one of the series of standards on electronic measuring equipment. A list of standards so far prepared in this series is given on page 16.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the general requirements and the characteristics to be specified for direct reading, pointer indicator type electronic voltmeter for measurements of direct or alternating voltages or both.

1.1.1 This standard does not cover the requirements of external accessories associated with the voltmeter that may be necessary for the measurement of resistance, capacitance, inductance, etc.

1.1.2 This standard does not cover digital type electronic voltmeter.

2. TERMINOLOGY AND EXPLANATION OF TERMS

2.0 For the purpose of this standard the following definitions and explanations of terms shall apply.

2.1 Electronic Voltmeters

2.1.1 *Electronic Voltmeter* — An electronic instrument for measuring direct or alternating voltages or both, which includes an amplifier or an amplifier together with a rectifier, associated with an indicating electrical measuring instrument, generally of the permanent-magnet moving-coil type, the scale of which is marked in terms of input voltages. Rectification and/or amplification is obtained by means of thermionic tubes semiconductor devices, magnetic devices or a combination of these devices.

NOTE — These instruments are generally characterized by their wide frequency range and high input impedance.

2.1.2 *Selective Voltmeter* — A voltmeter intended for measuring in a well defined and, as a rule, narrow frequency band. The band width and the position of the pass-band within a specified frequency range may be variable (adjustable).

2.1.3 *Symmetrical/Balanced Voltmeter* — A voltmeter having nominally equal impedances between each input terminal and frame, and intended for measuring voltage opposite in phase relative to frame.

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*Rules for rounding off numerical values (*revised*).

2.1.4 *Differential Input Voltmeter* — A voltmeter having two input terminals and intended for measuring the voltage between these terminals, irrespective of the voltage which these terminals may have relative to frame.

NOTE — The ratio of the measured value of a voltage between the two input terminals of a differential voltmeter and the measured value of the same voltage between frame and the same two terminals connected together is called the common mode rejection factor.

2.2 Characteristics

2.2.1 *Input Voltage* — The voltage to be measured, applied between the input terminals.

2.2.2 *Input Admittance/Impedance* — The admittance/impedance measured between the input terminals of the voltmeter in normal operating conditions.

NOTE— The corresponding input circuit may be represented by the value of a resistance and a capacitance connected in parallel.

2.2.3 *Equivalent Input Admittance/Impedance* — The admittance/impedance of a circuit formed by a parallel combination of a resistance and a capacitance which absorbs for given conditions of frequency and voltage the same power as the input circuit of the voltmeter and through which flows a reactive current equal to the component at the fundamental frequency of the current flowing into the input circuit of the voltmeter.

NOTE — This applies when the input circuit of the voltmeter is such that the current flowing through it is a non-linear function of the instantaneous input voltage.

2.2.4 *Warm-up Time* — The time interval after switching on the voltmeter, under reference conditions, necessary to enable it to comply with all the accuracy requirements.

2.2.5 *Settling Time* — The time taken by the moving element of voltmeter to come to its equilibrium position, within a specified tolerance, when a voltage with constant value is applied between the input terminals of the voltmeter under specified conditions.

2.2.6 *Swinging* — The oscillation of the pointer of the voltmeter which may occur when the frequency of the measured voltage is very close to the supply frequency or multiple thereof.

2.2.7 *Maximum Permissible Voltage* — Maximum voltage that can be fed as input signal to the voltmeter without any damage to the instrument.

2.2.8 *Recovery Time* — The time interval required after the removal of a maximum specified overload input value before a measurement within the stated accuracy can be started.

2.3 Ratings

2.3.1 *Rated Value* — The value (or one of the values) of the quantity measured, which is referred in the designation of the voltmeter.

2.3.2 *Rating* — The value of the quantity which corresponds to the upper limit of the effective range.

2.4 Constructional Parts

2.4.1 *Index* (*Pointer*) — The means which indicate the position of the moving part of the voltmeter.

2.4.2 *Scale* — A series of markings and number on the dial from which the value of the voltage measured is obtained.

2.4.3 *Dial* — The surface which carries the scale and numbers.

2.4.4 *Scale Marks* — The marks which enable the position of the moving element of the voltmeter to be identified.

2.4.5 *Scale Division* — Interval between two consecutive scale marks.

2.4.6 *Total Scale Length* — The length of the arc (or the segment of a straight line) passing through the centre of the shortest markings on the scale.

2.4.7 *Effective Range* — That part of the scale where measurements can be made with the stated accuracy.

2.4.8 *Maximum Value of the Effective Range* — The value of the measured quantity to which reference is made in specifying the accuracy of voltmeters.

2.4.8.1 When the zero is at one end of the scale, the maximum corresponds to the upper limit of the effective range.

2.4.8.2 When the zero is within the scale, the maximum is equal to the sum of the absolute values corresponding to each of the two limits of the effective range.

2.4.8.3 When the zero is off the scale, the maximum is equal to the difference between the values corresponding respectively to the upper and lower limits of the effective range.

2.4.9 *Input Terminals* — Connection points of the voltmeter, between which the voltage to be measured is applied.

2.4.10 *Probe* — An input device of a voltmeter made as a separate small unit and connected to it by means of a flexible cable.

2.5 Error and Variation in Indication

2.5.1 *Intrinsic Error* — The error determined when the voltmeter is under reference conditions.

NOTE — The error shall be expressed as a percentage of the maximum value of the effective range except in the case of logarithmic or hyperbolic scaled voltmeters where the error shall be expressed as a percentage of the total scale length.

2.5.2 *Absolute Error* — The measured (or indicated) value of a quantity minus its true value (that is, exact value of the quantity that is being measured) expressed algebraically.

2.5.3 *Relative Error* — The ratio of the absolute error to the true value of the quantity that is being measured.

2.5.4 *Percent Error* — The relative error expressed as a percentage.

2.5.5 *Variation in Indication* — The difference between the measured values of a voltage when an influence quantity assumes successively two specified values.

2.5.6 *Maximum Variation in Indication* — The maximum difference between measured values of a voltage when an influence quantity assumes all the values between specified limits.

2.5.7 *Deviation of the Electrical Zero* — The difference between the two equilibrium positions of the electrical zero when an influence quantity assumes successively two specified values.

2.5.8 *Fluctuation of the Electrical Zero/Index* — Random deviations of the electrical zero/index.

2.5.9 *Drift of the Electrical Zero/Index* — The generally slow and unidirectional deviation of the electrical zero/index as a function of time.

2.6 Influence Quantities and Reference Conditions

2.6.1 *Influence Quantity* — One of the quantities such as temperature, external magnetic field, time etc, which affect the indications of a voltmeter but which is not the one measured by it.

2.6.2 *Reference Conditions* — The specified conditions under which the voltmeter meets the requirements concerning intrinsic errors. These conditions determine the reference values or reference ranges for influence quantities.

2.6.3 *Reference Value* — A single value of an influence quantity at which the voltmeter complies with the requirements concerning intrinsic errors.

2.6.4 *Reference Range* — A range of values of an influence quantity within which the voltmeter complies with the requirements concerning intrinsic errors.

2.6.5 *Nominal Range of Use* — A range of values (generally assigned by the manufacturer) which any of the influence quantities may assume without the variation in indication of the voltmeter exceeding the limits specified.

2.7 Accuracy Error and Variation in Indication

2.7.1 *Accuracy* — The accuracy of a voltmeter is defined by the limits of intrinsic error and limits of variation in indication due to influence quantities.

2.7.2 *Accuracy Class of Voltmeter* — Classification of voltmeters the accuracy of which may be designed by a common number, this being the upper limit of permissible error (expressed in percent) when the voltmeter is used under reference conditions.

2.7.2.1 A voltmeter is considered as belonging to a stated accuracy class provided that it conforms to the prescribed limits relevant to that class:

a) for intrinsic error under reference conditions,
b) for variation in indication due to influence quantities, and
c) for deviation of electrical zero due to influence quantities.

The designation of number is termed the ' class index '.

2.8 Controls

2.8.1 *Mechanical Zero* — The equilibrium position of the moving element [shown by the index (pointer) on the scale] when the voltmeter is disconnected from the power supply and with no voltage applied between the input terminals and with the instrument in the normal operating position.

2.8.2 *Mechanical Zero Adjuster* — The mechanism by means of which it is possible to bring the index (pointer) to the appropriate mark for the mechanical zero.

2.8.3 *Electrical Zero* — The equilibrium position of the moving element (shown by the index on the scale) with the voltmeter switched on but with no voltage applied between its input terminals, these input terminals being protected from external fields and only connected to an external circuit when this is specifically indicated by the manufacturer.

NOTE — The deviation of electrical zero shall be expressed as percentage of the total scale length.

2.8.4 *Electrical Zero Adjuster* — The means by which it is possible to shift the electrical zero to an appropriate mark, in particular to the zero of the graduation.

2.9 Miscellaneous

2.9.1 *Type Tests* — Tests carried out to prove conformity with the requirements of these standards. These tests are intended to prove general quality and design of a given type of instrument.

2.9.2 *Acceptance Tests* — Tests carried out on a sample selected from a lot for the purpose of performing the acceptance of the lot.

2.9.2.1 *Lot* — All instruments of the same tpye, category and rating manufactured by the same factory during the same period using the same process and materials.

2.9.3 *Routine Tests* — Tests carried out on each instrument to check the requirements which are likely to vary production.

3. CONSTRUCTIONAL REQUIREMENTS

3.1 Scale

3.1.1 *Scale Division* — The value of each scale division shall be either 1, 2 or 5 of the units measured or any decimal multiple or sub-multiple of these numbers.

3.1.2 *Figuring and Scale Numbering* — Scales shall, in general, be figured at suitable long or medium scale marks, but not at both, except, that the scale-end marks may be figured irrespective of their length.

3.1.2.1 The digits shall be of such shape as to minimize the risk of different digits being confused with one another and shall be so spaced as to render individual groups clearly distinguishable from adjacent groups. Where necessary, for this purpose, the noughts may be reduced in size.

3.1.2.2 The unit of scale numbering shall be so chosen that the numerals (whole number or decimal marked on the dial) shall not have more than three digits.

3.1.3 *Direction of Scale* — The direction of the scale corresponds to the positive increasing values of the scale numbering. The normal direction is fixed from left to right or from bottom to top. When the angular deflection of the index exceeds 180 degrees, the direction of the increasing values of the scale numbering shall be clockwise. On multiple-scaled instruments, at least one of the scales shall be in the normal direction.

3.1.4 *Width of Scale Division* — The width of the scale division for the voltage range of the instrument shall be not less than 0·8 mm measured along the centre of the shortest scale marks, the instrument being provided with a knife-edge pointer and anti-parallax mirror.

3.1.5 *Construction of Scale* — Scale shall consist of long or medium or both and short scale marks. The scale divisions shall be consistant with the requirements of **3.1.4**. The medium scale mark shall be not less than 1·3 times or more than 1·5 times the length of the short scale-mark. The long scale mark shall be not less than 1·7 times or more than 2·0 times the length of the short scale mark.

3.1.5.1 The thickness of the short scale marks shall not differ noticeably from the thickness of that portion of the index which moves over the scale marks. In the case of those instruments which are intended to be read from a distance numbers and other salient marks may be thickened.

3.2 Index (Pointer)

3.2.1 The pointer shall be light and rigid and so shaped as to lend itself to easy and accurate reading.

3.2.2 The pointer shall be insulated from the electric circuit of the instrument unless the scale plate is at substantially the same potential as the pointer and is insulated from the case.

3.2.3 In any instrument not provided with means for avoiding errors of reading due to parallex, the clearance between the scale and the portion of the pointer which traverses it, shall be not more than 1·5 mm or 1/100 of the length of the scale whichever is greater.

3.2.4 The length of a pointer other than knife-edge pointer shall be such that the tip extends over more than one-third, but not over more than two-thirds of the length of the shortest scale mark.

3.2.5 A knife-edge pointer shall extend over the whole length of the short scale marks but not appreciably beyond them.

3.2.6 The thickness of the pointer knife-edge shall not exceed 0·2 mm.

3.2.7 For an instrument fitted with a mirror, the knife-edge of the pointer shall be coloured red on the top-edge.

3.3 In case of logarithmic and hyperbolic scaled instrument, it is desirable to provide anti-parallax mirror.

3.4 Limits of Effective Range — When the effective range does not correspond to the total scale length, the limits of the effective range shall be marked on the scale. It is, however, unnecessary to mark the limits of the effective range when the value of the scale division or the nature of the scale marks enable the range to be identified without ambiguity.

3.4.1 The ratings of effective ranges shall preferably be chosen from the following basic series or their decimal multiples or fractions:

a) 1, $\sqrt{10}$, 10 (for voltage and dB); and

b) 1, 3, 10 (for voltage).

3.5 Normal Position of Use — The normal position of use of electronic voltmeter shall be either with the dial in vertical plane or inclined at 30° to the vertical unless specified otherwise.

3.6 Connectors and Terminals — Types of connectors and terminals provided shall be indicated.

3.6.1 If so required for the correct use of the instrument, the terminals shall be clearly marked to show the proper method of connections.

3.7 Earthing

3.7.1 The instruments having metal easing shall have provision for distinct connections to earth as follows:

Voltage of Circuit in which Instrument is used V	*Number of Connections to Earth*
250 and below	1
Above 250	2

3.7.1.1 These terminals shall be provided over and above all other means for securing metallic enclosures of current carrying cables.

3.7.2 The earthing terminals shall be readily accessible and so placed that the earth connection of the instrument is maintained when the cover or any other movable part is moved.

3.7.3 The earthing terminals shall be of adequate size, protected against corrosion and shall be metallically clean. Under no circumstances shall a movable metal part of the enclosure be insulated from the part carrying the earthing terminal when the movable part is in place.

3.7.4 The earthing terminal shall be identified by means of a sign ⏚ marked in a legible and indelible manner on or adjacent to the terminals.

4. CLASSIFICATION

4.1 The accuracy class should be chosen from the following values:

0·1, 0·2, 0·5, 1·0, 1·5, 2·5, 5·0 and 10·0.

5. WORKMANSHIP AND FINISH

5.1 Workmanship — All parts shall be manufactured and assembled in accordance with the current engineering practice.

5.2 Finish — All exposed metal parts shall be painted or otherwise protected to prevent corrosion under normal conditions of use.

6. CONTROLS AND ADJUSTMENTS

6.1 Mechanical Zero Adjustment — The range of mechanical zero adjustment, when provided, shall not exceed 6 percent of the scale length. The ratio of the amplitude of the adjustment on either side of zero shall not be greater than 2.

6.2 Electrical Zero Adjustment — Facilities for electrical zero adjustment, shall be provided. The range of adjustment shall be continuous and sufficient.

6.3 Polarity Changing Switch — The polarity changing switch or other suitable arrangements may be provided for dc measurements.

7. POWER SUPPLY

7.1 Mains Operation — The instrument shall be designed for operation on nominal voltage of 240 V. Adjustable internal links to enable operation on voltages of 220, 230, 240 and 250 V may, if necessary, be incorporated in the instrument.

7.1.1 *Frequency* — Electronic voltmeter operating on ac mains shall be designed for nominal mains frequency of 50 Hz.

7.2 Battery Operation — Primary batteries of the type and voltage specified for the instrument and in accordance with the relevant Indian Standards shall be used.

NOTE — For transistorized instruments operated from dry batteries, it should be noted that 6 V and 9 V are likely to be readily available battery voltages.

7.3 Influence of Variation of Power Supply

7.3.1 *Mains Operation* — The instrument shall be so designed that the limits of permissible variation shall not be exceeded when the mains supply is varied by ± 10 percent from rated supply voltage.

7.3.2 *Battery Operation* — The instrument shall hold its specified accuracy when the voltage of the battery attains a limit of 80 percent of its rated voltage.

8. CHARACTERISTICS OF ELECTRONIC VOLTMETERS

8.1 The values for the following characteristics of the electronic voltmeters shall be specified in the individual specification:

a) Accuracy class or class index (*see* **4.1**);
b) Voltage ranges;
c) Permissible intrinsic error(s);
d) Frequency range;
e) Type of input such as single ended, balanced, symmetrical;
f) Input admittance/impedance;
g) Nature of calibration;
h) Warm-up period; and
j) Maximum permissible input voltage.

8.2 The values for the following characteristics also shall be included in the individual specification, wherever applicable:

a) Deviation of electrical zero due to:
   1) influence of ambient temperature,
   2) influence of supply voltage variation,

  3) application of highest range voltage, and
  4) change of range.
- b) Fluctuation of electrical zero
- c) Drift of electrical zero
- d) Variation in indication due to:
  1) change of normal position of operation,
  2) influence of ambient temperature,
  3) influence of external magnetic field,
  4) influence of external electric field,
  5) influence of external RF electromagnetic field,
  6) influence of supply voltage, and
  7) influence of super-imposed input voltage.
- e) Swinging of the index
- f) Fluctuation of index
- g) Drift of index
- h) Damping due to:
  1) overshoot, and
  2) settling time.

9. MARKING

9.1 Markings and Symbols for Electronic Voltmeters — Each voltmeter shall have on the scale plate of its indicating instrument and on one of its external surfaces, preferably on the front panel, the marking listed in **9.1.1** and **9.1.2**. The markings shall be given by the symbols described in IS : 2032 (Part X)-1969*.

9.1.1 *Markings and Symbols which shall Appear on the Scale Plate* — The unit of the measured quantity (the voltage) indicated by its symbol.

9.1.2 *Markings and Symbols which shall Appear on One of the External Surface of the Voltmeter*

- a) Accuracy class or class index;
- b) Rating of the voltmeter in terms of the measured voltage;
- c) Indication of the reference position;
- d) Manufacturer's name and trade-mark;
- e) The designation;

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*Graphical symbols used in electrotechnology : Part X Measuring instruments.

- f) Type and serial number of the voltmeter;
- g) Rated supply voltage and frequency, if ac; and
- h) A suitable symbol to show that some other essential information is given in the technical document.

10. TECHNICAL DOCUMENTATION TO BE SUPPLIED BY THE MANUFACTURER

10.1 A technical document shall be supplied by the manufacturer with each instrument. This shall be prepared in accordance with IS : 6756-1972*. All the information given in **8.1** and **8.2** and relevant details of those given in **9.1.2** shall be repeated and more fully described in the technical document together with the following:

- a) The voltage for the breakdown test on the measuring circuit;
- b) Reference values or ranges of all influence quantities;
- c) Accuracy corresponding to the different voltage ranges;
- d) The nature of the input circuit and the values of the elements representative of the input impedance/admittance with their tolerances;
- e) Frequency ranges corresponding to different variation in indication;
- f) The nature of calibration, namely peak, rms, average, etc;
- g) Settling time;
- h) Recovery time;
- j) Nominal ranges of use;
- k) Storage conditions; and
- m) Transport conditions.

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*Technical documentation to be supplied with electronic measuring equipment.

(*Continued from page* 2)

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INDIAN STANDARDS

ON

ELECTRONIC MEASURING EQUIPMENT

IS:	
2320-1963	Methods of measurements for amplitude modulated radio frequency signal generators (30 kc/s to 30 Mc/s)
2321-1963	Requirements for general purpose amplitude modulated radio frequency signal generators (30 kc/s to 30 Mc/s)
2711-1966	Direct reading *p*H meters (*revised*)
3437-1972	General requirements for direct reading pointer indicator type electronic voltmeter (*first revision*)
3886-1966	Minimum requirements for general purpose audio frequency signal generators (30 c/s to 30 kc/s)
3915-1966	Methods of measurements on audio frequency signal generators (30 c/s to 30 kc/s)
4309-1967	Methods of measurement on direct reading *p*H meters
4330-1967	Methods of measurement on cathode-ray oscilloscope (dc to 10 Mc/s)
6700-1972	Requirements for general purpose cathode-ray oscilloscope
6756-1972	Technical documentation to be supplied with electronic measuring equipment
6767 (Part I)-1972	Direct reading pointer indicator type ac/dc electronic voltmeter: Part I Methods of measurements
6767 (Part II)-1972	Direct reading pointer indicator type ac/dc electronic voltmeter: Part II Up to 30 MHz
6767 (Part III)-1972	Direct reading pointer indicator type ac/dc electronic voltmeter: Part III Up to 300 MHz
6769 (Part I)-1972	Direct reading pointer indicator type ac electronic millivoltmeter: Part I Methods of measurements
6769 (Part II)-1972	Direct reading pointer indicator type ac electronic millivoltmeter: Part II With a frequency range of 2 Hz to 1 MHz
6804-1972	Glass electrodes for direct reading *p*H meters

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